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I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PS 3108 for a patent by INDUSTRIAL ROLL FORMERS PTY LIMITED as filed on 21 June 2002.

WITNESS my hand this
Second day of July 2003

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INDUSTRIAL ROLL FORMERS PTY LTD

AUSTRALIA
Patents Act 1990

PROVISIONAL SPECIFICATION FOR THE INVENTION ENTITLED:

"YIELDING CABLE BOLT".

The invention is described in the following statement:-

YIELDING CABLE BOLT

The present invention relates to cable bolts and, in particular, to a yielding cable bolt intended to control the movement of unstable rock strata into which the bolt is installed.

Rock strata are liable to move as a result of various developments including mine-induced seismicity, the excavation of perimeter rock, minor earthquakes, and the like. Some such movements are termed "rock bursts".

In general, regular rock bolts are insufficient to withstand such movement and snap. In the past various proposals have been made. One such proposal is the so called DURABAR or DURABOLT (South African Patent No. 94/2177) invented by D Ortlepp which provides a heavy solid steel bar with a wriggle-like deformation. The bar is grouted in place at installation. As a consequence, in the event of ground movement, the deformed portion of the bar pulls through the grout and this absorbs a considerable amount of energy.

A similar arrangement is to shape the far end of the bar into a conical form which is embedded in grout. The shank of the bar is coated with wax which means that this part of the bar does not bond with the grout. In the event of excessive forces being applied to the bar, the conical end is forced or pulled through the grout. Again this absorbs a considerable amount of energy.

An alternative arrangement is to insert a mild steel slug within a multi strand steel cable. A tapered sleeve is then placed over the cable. In the event of rock movement, the intention is to extrude the slug through the cable wires which are held in place by the tapered sleeve thereby giving a high pull through force and absorbing a considerable amount of energy. This arrangement is difficult to use in such a way as to give reproducible results and is time consuming to assemble.

The object of the present invention is to provide a yielding cable bolt which is easy to fabricate and assemble and which provides a substantially predictable and repeatable result.

According to a first aspect of the present invention there is disclosed a yielding cable bolt to control the movement of unstable rock strata into which the bolt is installed, said bolt comprising a portion of said cable having a grout slippage means and a grout engaging anchor

located on said portion whereby in yielding said cable portion passes through said anchor and is worked thereby.

In accordance with a second aspect of the present invention there is disclosed a method of permitting a cable bolt to yield to control the movement of unstable rock strata into which the bolt is installed, said method comprising the steps of:

(i) providing a portion of said cable with a grout slippage means;

(ii) providing at least one grout engaging anchor on said portion;

(iii) installing said cable bolt in a hole drilled in said rock strata;

(iv) introducing flowable hardenable grout into said hole to surround said cable bolt, said portion, and said anchor(s); and

(v) permitting said portion to move through said grout but be worked by moving through said anchor(s) which is/are substantially immobilized in said grout.

Embodiments of the present invention will now be described with reference to the drawings in which:

FIG 1 is a perspective view of a bulge portion of a prior art multi-strand steel cable;

FIG 2 is a longitudinal view, partly in section, of the cable portion of FIG 1 installed as a rockbolt;

FIG 3 is an exploded perspective view of a grout engaging anchor;

FIG 4 is an exploded perspective view of the anchor of FIG 3 during assembly onto a portion of a cable;

FIG 5 is a perspective view showing the assembled grout engaging anchor;

FIG 6 is a longitudinal sectional view through the assembled anchor of FIG 5;

FIG 7 is a view similar to FIG 6 but of a second embodiment but of the anchor of FIGS 3 to 6;

FIG 8 is an exploded perspective view illustrating a yielding cable bolt in accordance with a first embodiment of the present invention;

FIG 9 is a longitudinal view, partly in section, illustrating the bolt of the type shown in FIG 8 after installation;

FIG 10 is a view similar to FIG 8 but illustrating a yielding cable bolt of a second embodiment; and

FIG 11 is a view similar to FIG 9 but of a cable bolt of the type shown in FIG 10.

Cable bolts are traditionally made from multi-strand steel cable 1 such as that illustrated in FIG 1. The cable is conveniently bulged at 2 in known fashion by gripping the cable 1 at two spaced apart locations and forcing the gripped regions together to permanently spring out, or bulge, the strands 3.

As illustrated in FIG 2, the intention of such a bulge 3 is to enable grout 5 which is normally used to surround the cable 1, to better the grip the cable 1 and so provide good keying between the cable 1 and the grout 5. Such grout 5 is often installed by means of a tube 6 of inexpensive plastics material through which the cable 1 passes.

Turning now to FIGS 3 to 6, a grout engaging anchor 10 is proposed which is fabricated from two complimentary shells 11 and 12, each of which forms half of the anchor 10. The shell 11 is provided with a single recess 14 whilst the shell 12 is provided with a single protrusion 15. The recess 14 and protrusion 15 are of complimentary shape. In addition, each shell 11 and 12 is provided with a half boss 17 at each end.

As indicated in FIG 4, the anchor 10 is assembled by passing the cable 1 through a close fitting tube 8 of inexpensive plastics material. The tube 8 is preferably manufactured from high density polyethylene (HDPE) and is widely used for irrigation purposes. The two shells 11 and 12 are then positioned as indicated in FIG 4 and clamped together so as to securely grip the cable 1 within the anchor 10. With the two shells 11 and 12 clamped together, a keeper ring 19 is passed over the two adjacent half bosses 17 at each end of the anchor 10. With both keeper rings 19 in place, the clamping force on the anchor 10 can be released since the half bosses 17 are then maintained within the keeper rings 19. This is the situation illustrated in FIGS 5 and 6.

FIG 7 illustrates a second embodiment of the anchor 100 in which the keeper rings 19 are as before but each of the shells 111 and 112 is provided with a recess 114 and a protrusion 115. As will become apparent hereafter, the purpose of the anchor 100 of FIG 7 is to provide a greater degree of work before the cable 1 can be passed therethrough.

Turning now to FIG 8, a first embodiment of a yielding cable bolt 21 is illustrated. The tendon 22 of the bolt 21 is fabricated from the multi-strand steel cable 1 and the near end is

provided with the threaded end fitting 23 which cooperates with a load plate 24, grout injector 25 and nut 26. The grout injector 25 works in a general manner described in Australian Patent No. 669,393 (WO 94/05900). In the embodiment illustrated in FIG 8, a single anchor 10 is secured adjacent the free end of the bolt 21, however, in the embodiment illustrated in FIG 9 a pair of spaced apart anchors 10 are so secured.

In the particular embodiment illustrated in FIG 9, three strata 30, 31 and 32 are illustrated and strata 30 and 32 are relatively strong whereas stratum 31 is relatively weak and liable to movement. The tube 8 covers the cable 1 essentially throughout the stratum 32 but does not cover the cable 1 essentially throughout the strata 30 and 31. As a consequence, there is good keying between the cable 1 and the grout 5 in the area of strata 30 and 31 but the far end of the cable bolt 21 is itself able to move relative to the grout 5 if necessary, notwithstanding that the two anchors 10 are securely fixed within the grout 5 within the stratum 32.

As a consequence, in the event that strata 30 and 31, for example, move to the left as seen in FIG 9, the cable 1 at the near end of the cable bolt 21 will move with the strata 30 and 31 due to the keying between the cable 1 and the grout 5. However at the far end of the cable bolt 21 the cable 1 covered by tube 8 is free to move relative to the grout 5 but the grout anchors 10 remain firmly secured relative to the grout 5. As a consequence, the cable 1 is plastically deformed by the anchors 10 as the cable 1 moves past the interengaged recesses 14 and protrusions 15.

As a result, considerable mechanical work is performed in moving the far end of the cable bolt 21 through the anchors 10. In this way, a considerable amount of energy is able to be rapidly dissipated thereby ensuring that the cable bolt 21 yields and absorbs the energy, but does not break.

FIGS 10 and 11 illustrate a second embodiment which is essentially as before save that prior art tube 6 is provided adjacent the near end of the cable bolt 21 and the far end of the cable bolt 21 is provided with an expansion anchor 35 which is formed as part of the anchor 10, or anchor 10 closer(est) to the far tip of the cable. The expansion anchor 35 enables installation of the bolt so as to permit post tensioning grouting. In addition, the uncovered region of the

tendon 22 (that is without the tube 8) is provided with a number of bulges 2 which function, as before, to increase the keying or interengagement between, the cable 1 and the grout 5.

As explained above in relation to FIG 9, the far end of the cable 21 of FIG 11 is able to plastically deform and move through the anchors 10 thereby absorbing the energy of the moving strata.

The foregoing describes only some embodiments of the present invention and modifications, obvious to those skilled in the art, can be made thereto without departing from the scope of the present invention.

The term "comprising" and its grammatical variations as used herein are used in the sense of "including" or "having" and not in the exclusive sense of "consisting only of".

ASPECTS OF THE INVENTION

The following paragraphs define some aspects of the present invention:

1. A yielding cable bolt to control the movement of unstable rock strata into which the bolt is installed, said bolt comprising a portion of said cable having a grout slippage means and a grout engaging anchor located on said portion whereby in yielding said cable portion passes through said anchor and is worked thereby.

2. The cable bolt as defined in paragraph 1 wherein said grout slippage means comprises a tube surrounding said portion of said cable.

3. The cable bolt as defined in paragraph 1 or 2 wherein said anchor comprises a body engageable with said grout and formed in two parts which are clamped together over said cable portion.

4. The cable bolt as defined in paragraph 3 wherein said parts include at least one inter-engaging protrusion and recess.

5. The cable bolt as defined in any one of paragraphs 1 to 4 and including a plurality of said grout engaging anchors.

6. A yielding cable bolt substantially as herein described with reference to the drawings.

7. A method of permitting a cable bolt to yield to control the movement of unstable rock strata into which the bolt is installed, said method comprising the steps of:

(i) providing a portion of said cable with a group slippage means;

(ii) providing at least one grout engaging anchor on said portion;

(iii) installing said cable bolt in a hole drilled in said rock strata;

(iv) introducing flowable hardenable grout into said hole to surround said cable bolt, said portion, and said anchor(s); and

(v) permitting said portion to move through said grout but be worked by moving through said anchor(s) which is/are substantially immobilized in said grout.

8. A method of permitting a cable bolt to yield to control the movement of unstable rock strata into which the bolt is installed, said method being substantially as herein described with reference to FIGS. 3 to 11 of the drawings.

Dated this 21st day of June 2002

INDUSTRIAL ROLL FORMERS PTY LTD
By:

HODGKINSON OLD McINNES
Patent Attorneys for the Applicant

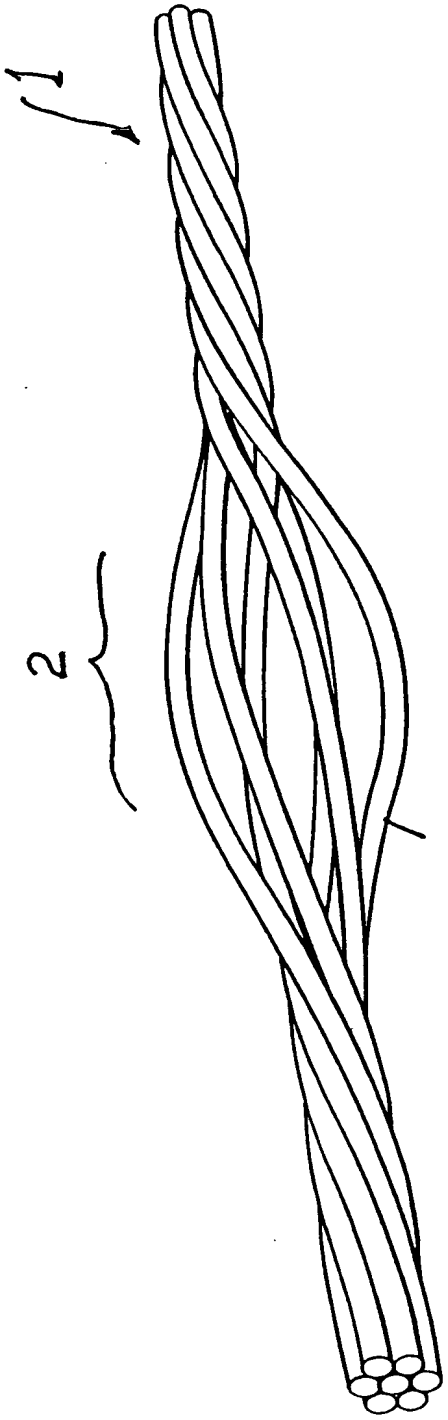

FIG. 1 PRIOR ART

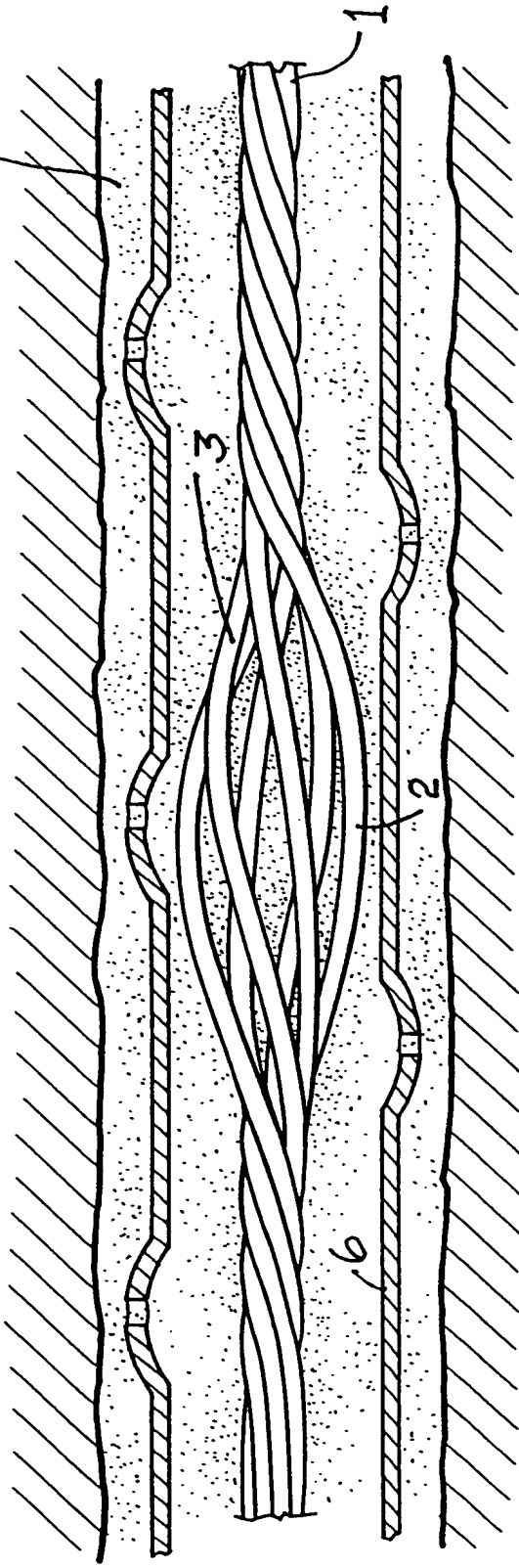

FIG. 2 PRIOR ART

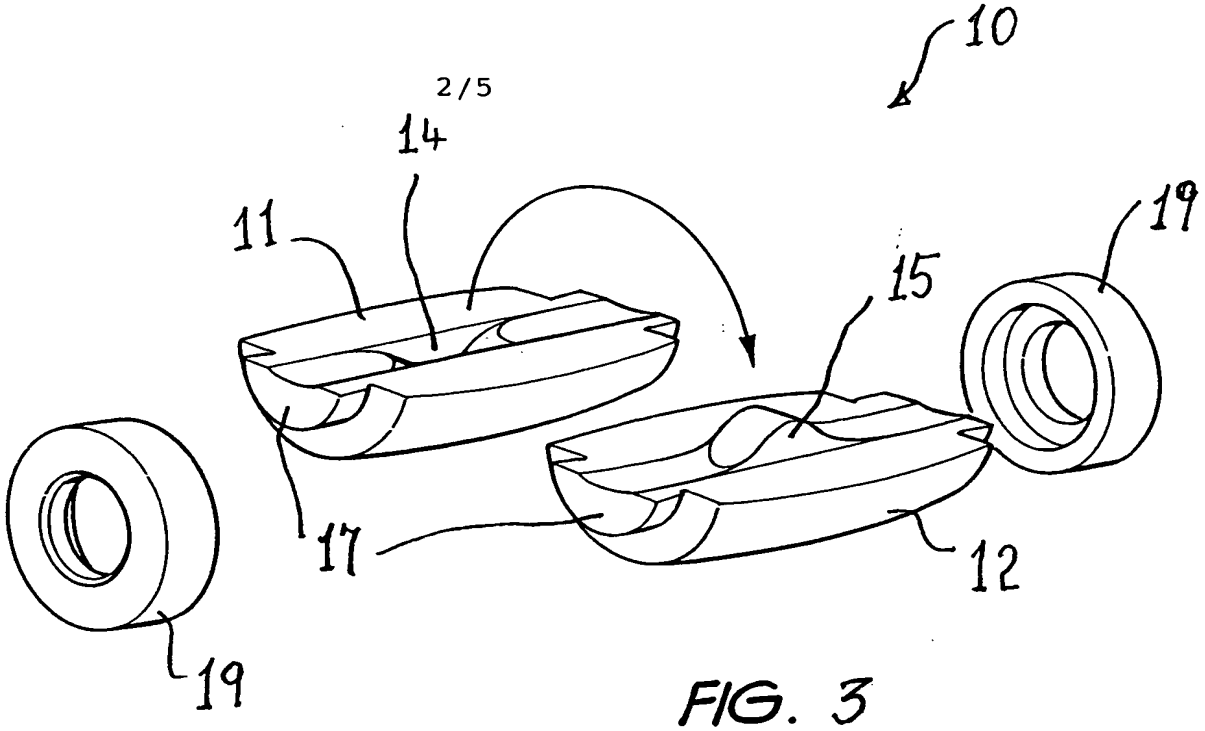

FIG. 3

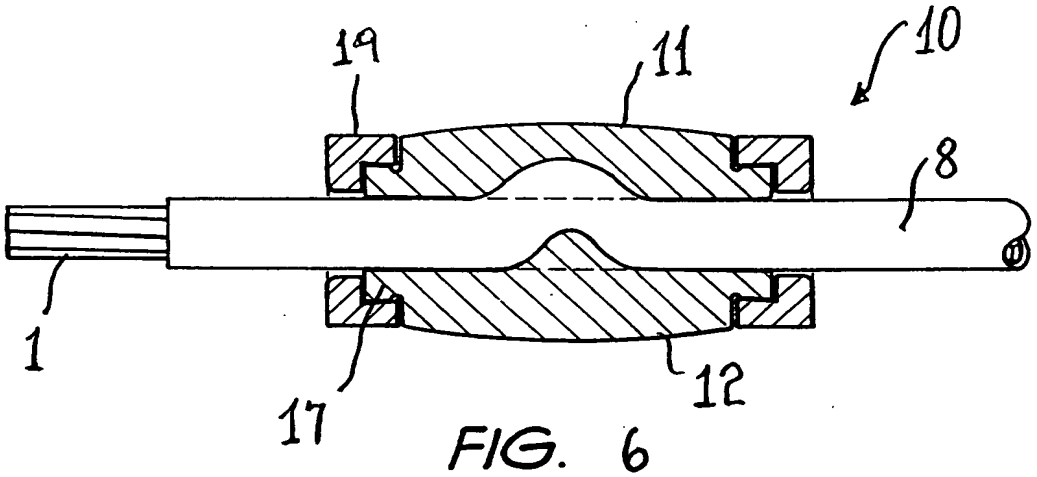

FIG. 6

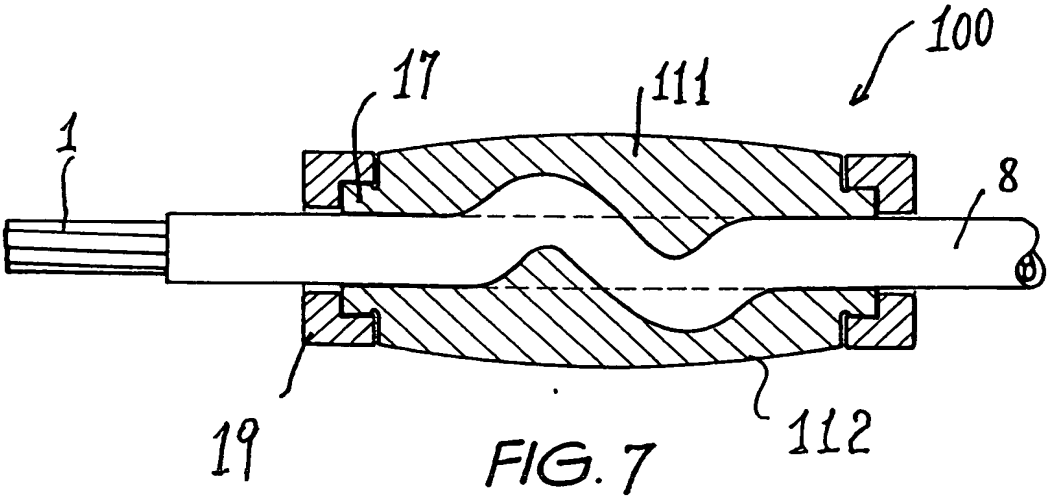

FIG. 7

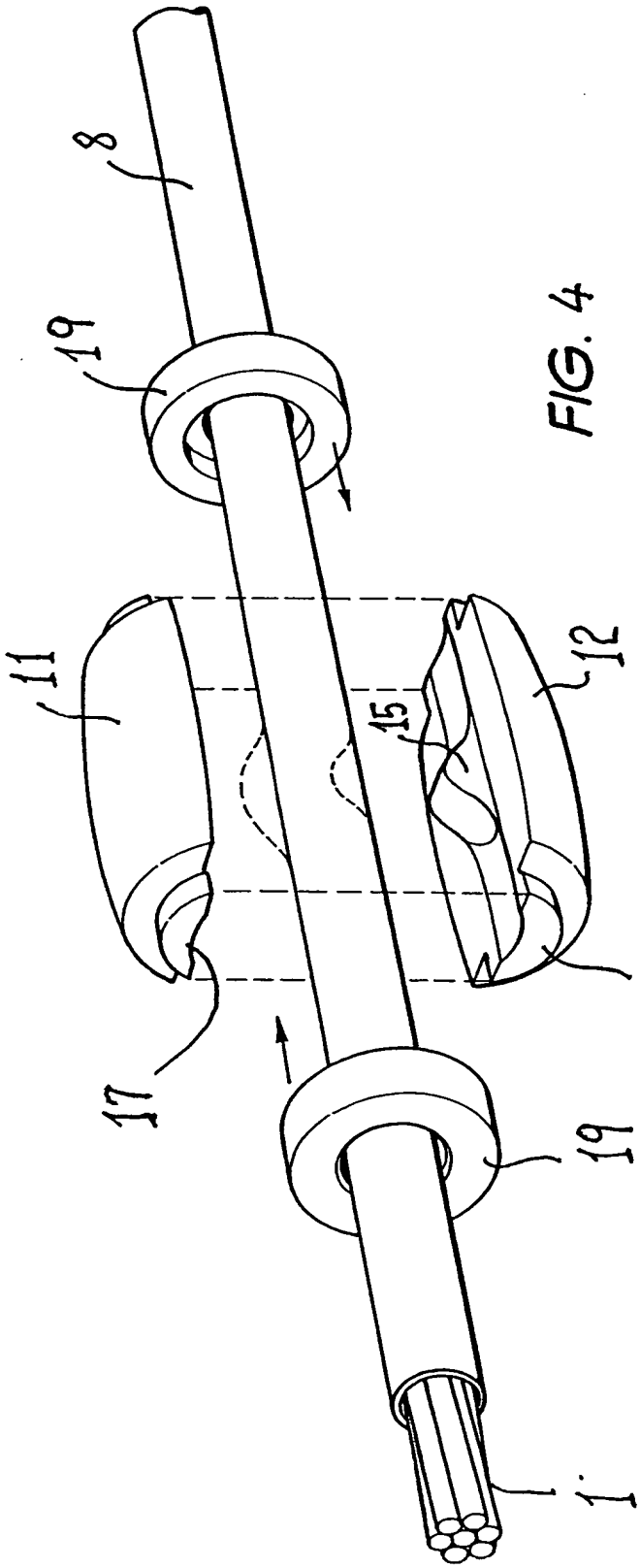

FIG. 4

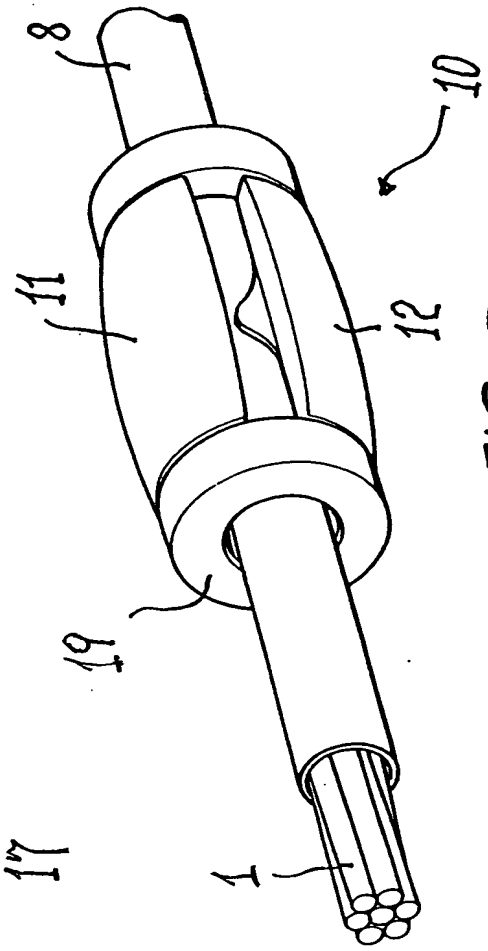

FIG. 5

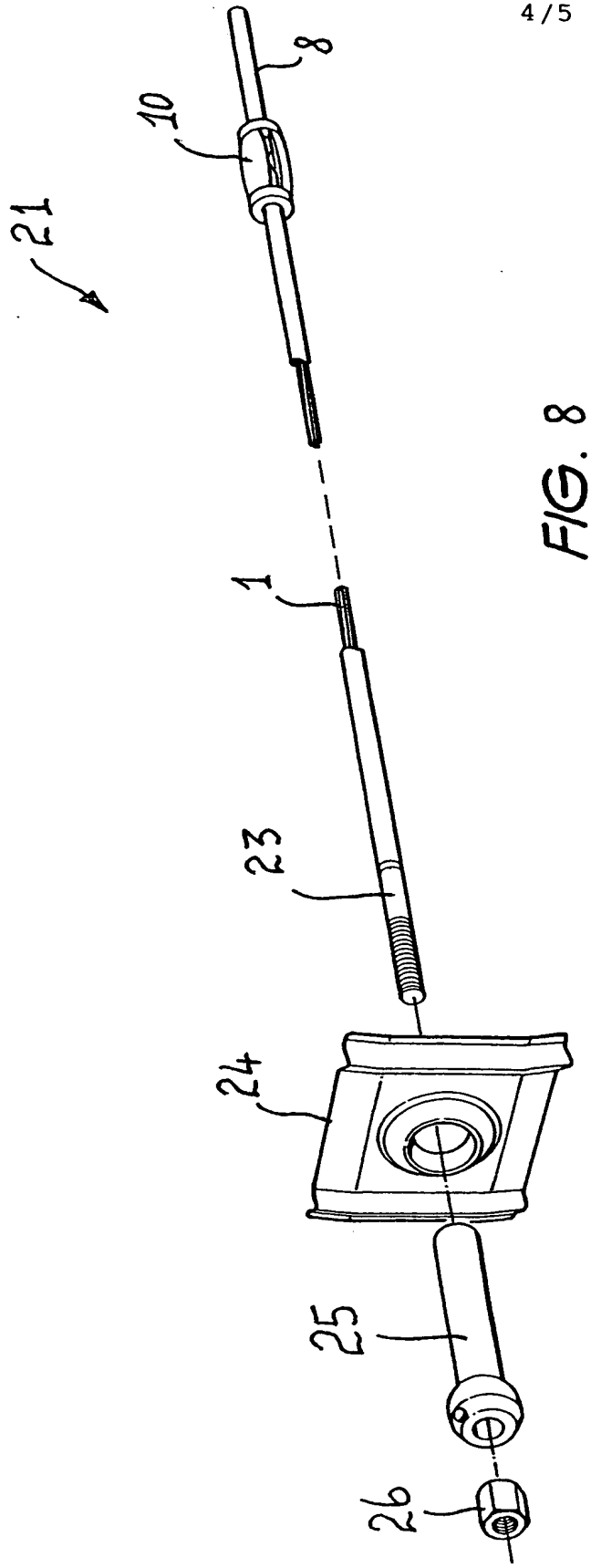

FIG. 8

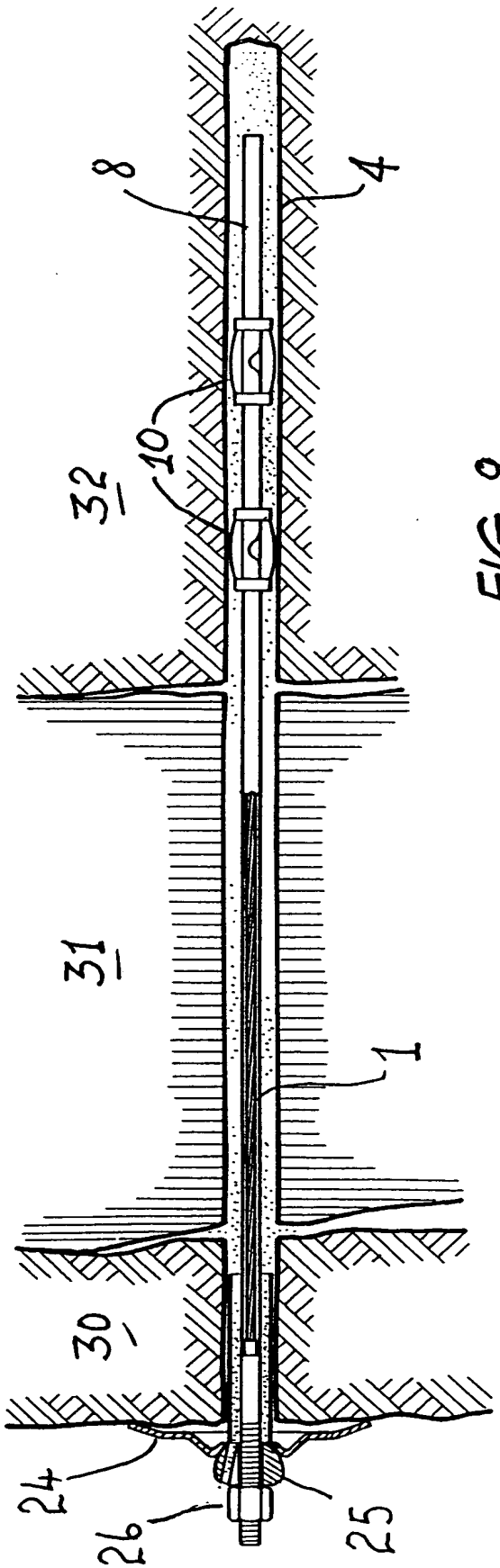

FIG. 9

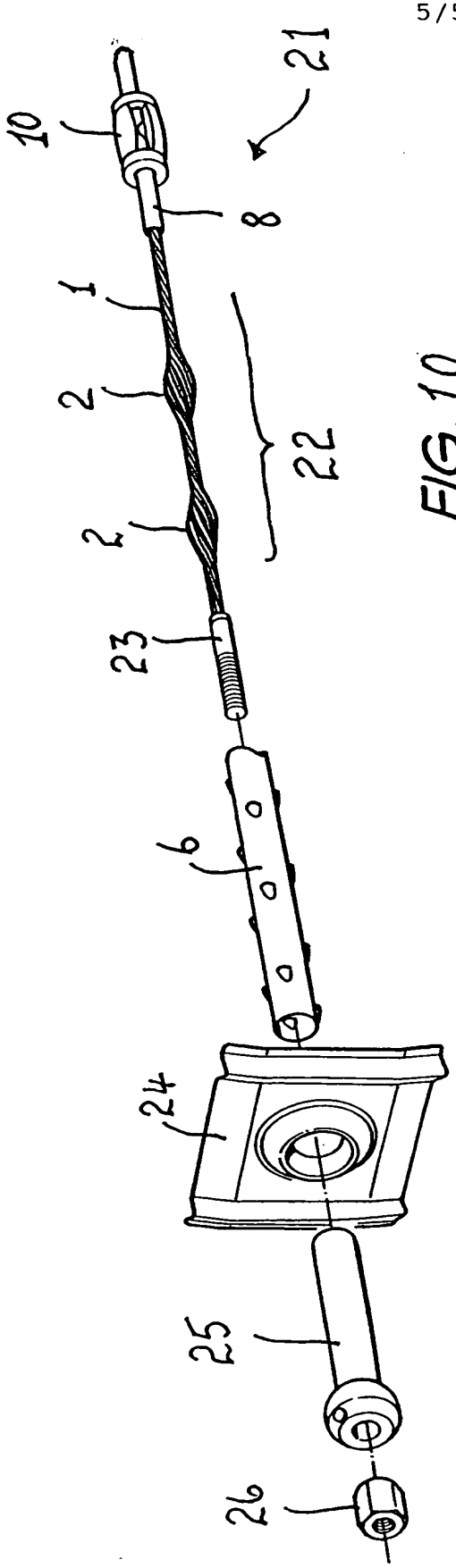

FIG. 10

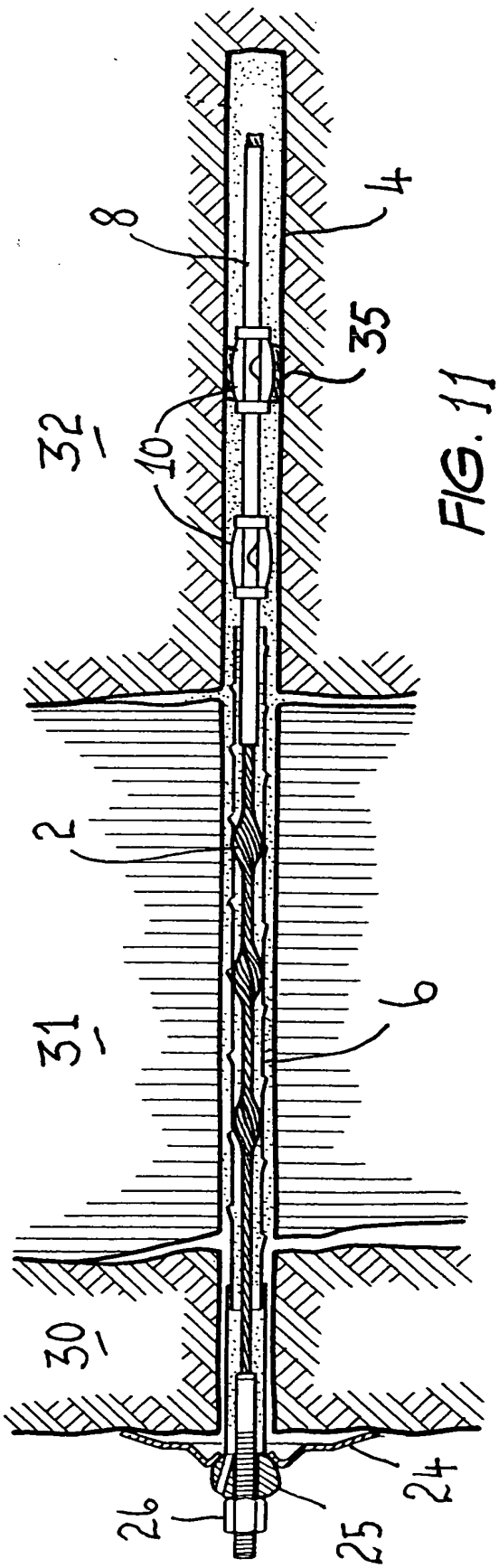

FIG. 11